

Method and apparatus for location finding in a CDMA system

Publication date: 1998-06-02

Applicant:

- international: H04Q7/34; G01S5/14

- european: G01S5/14; G01S5/14B; H04Q7/38L

Application number: JP19960534042T 19960321

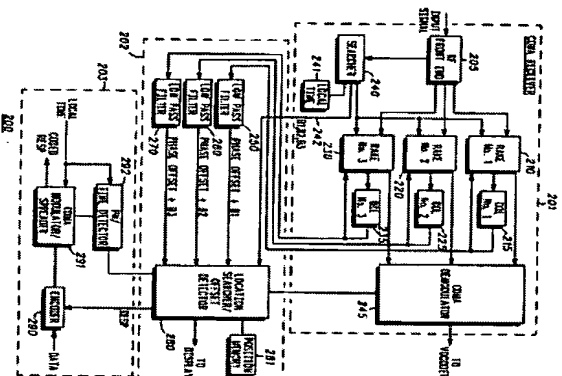
Priority number(s): WO1996US03797 19960321; US19950436760 19950508

WO9635958 (A1)
US5508708 (A1)
GB2304500 (A)
FR2734108 (A1)
FI965257 (A)

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Abstract not available for JP10505723T
Abstract of corresponding document: US5508708

A method and apparatus for determining the location of a communication unit in a CDMA system includes in a first embodiment, sending a location request via a spread spectrum signal to the subscriber (140), and receiving in return a subscriber signal including a response message showing a receive time of a particular symbol of the bases spreading sequence and a transmit time of a particular symbol of the subscriber's spreading sequence. The base (130), along with other receiving base(s) (140), also receives a predetermined symbol of the subscriber spreading sequence, and each determines a respective receive time of the predetermined symbol. The received information is then processed, along with known base location and delay information, to determine the subscriber location. If insufficient number of bases are capable of communicating with the subscriber, for example due to high fading/interference, auxiliary bases (121) are also provided for receiving from or transmitting to the subscriber.



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CLAIMS

[Claim(s)]

1. It is Approach of Determining Location of Subscriber Unit in Wireless Communication System. : Phase of Sending 1st Signal Which Includes Location Specification Demand from 1st Base Station to Subscriber Unit.

Phase where are the phase of receiving the 2nd signal including a response message from a subscriber unit, and a response message is constituted by the receipt time of the 1st signal, and the transmitting time of day of the 2nd signal.

In the 1st base station and the 2nd base station, the predetermined notation relevant to the 2nd signal is received. The phase of determining the 1st and 2nd receipt time of the predetermined notation in the 1st and 2nd base stations, respectively, it reaches. The receipt time of the 1st signal by the subscriber unit, the transmitting time of day of the 2nd signal by the subscriber unit, and the 1st and 2nd receipt time of a predetermined notation, Phase of determining the location of a subscriber unit from the predetermined information about the 1st and 2nd base stations:

The approach characterized by constituting "Be alike."

2. Approach according to claim 1 by which said predetermined information is constituted by location and processing delay information.

3. It is Wireless Communication System Which Pinpoints Location of Communication Link Unit : It is (a) 1st Base Station. : 1st Base Station Transmitter Which Sends 1st Diffuse-Spectrum Signal Including (i) Location Specification Demand to Communication Link Unit.

(ii) The 1st base station receiver further constituted by the 1st base station detector which is the 1st base station receiver which receives the 2nd diffuse-spectrum signal equipped with the response message containing the receipt time of the 1st signal, and the transmitting time of day of a signal from a communication link unit, receives the predetermined notation of the 2nd signal from a communication link unit, and determines the 2nd receipt time of a predetermined notation:

The 1st base station constituted as be alike:

(b) 2nd base station: constituted by the 2nd receiver which receives the predetermined notation of the 2nd signal and determines the 2nd receipt time of a predetermined notation — and — it is the controller which answers the (c) 1st and 2nd base stations. With the receipt time of the 1st signal Controller which consists of transmitting time of day of the 1st signal, the 1st and 2nd receipt time of a predetermined notation, and predetermined information about the 1st and 2nd base stations with a means to determine the location of a communication link unit.

Wireless communication system characterized by constituting "Be alike."

4. It is Approach of Determining Location of Subscriber Unit in Communication System. : Phase of Receiving Signal Formed through Modulation by Sequence of Diffusion Notation from Subscriber Unit in (a) 1st Base Station and, and 2nd Base Station.

(b) Phase of determining the 1st receipt time of one notation among the sequences of the diffusion notation in the 1st base station.

(c) phase: which determines the 2nd receipt time of the notation in the 2nd base station — and — Phase: which determines the location of a subscriber unit as the (d) 1st and 2nd receipt time

from the predetermined information about the 1st and 2nd base stations further

The approach characterized by constituting "Be alike."

5. It is Communication System Which Has Two or More Base Stations and Can Pinpoint Location of Communication Link Unit. : Receiver with which Each Can Receive Signal Formed through Modulation by Sequence of Diffusion Notation from Communication Link Unit. The controller which is constituted by the detector which can determine the receipt time of a notation with a sequence and which answers the 1st and 2nd base stations: it reaches. A controller is answered. Location processor which can require that the 1st and 2nd receipt time of the specific notation of a sequence should be determined to the 1st and 2nd base stations, and can determine the location of a communication link unit from the 1st and 2nd receipt time and the further information about the 1st and 2nd base stations:

Communication system characterized by constituting "Be alike."

6. It is Approach of Determining Location of Subscriber Unit Which Communicates in Wireless Communication System Which Has Two or More Base Stations, and it is within Subscriber. : (A) It is Phase Where of are Phase of Receiving 1st Signal from 1st Base Station among Two or More Base Stations, and Receiving 2nd Signal from 2nd Base Station among Two or More Base Stations, and 1st and 2nd Signals are Formed Based on 1st Sequence of Notation, and 2nd Sequence of Notation, Respectively;

(b) Another notation of the 1st receipt time of the 1st notation of the 1st sequence, and the 2nd sequence

The phase of determining the **** 2 receipt time; it reaches. Phase of determining the location of a subscriber unit from the (c) 1st and 2nd receipt time, and the further information about the 1st and 2nd base stations:

The approach characterized by constituting "Be alike."

7. Approach according to claim 6 the 1st and 2nd sequences are the same sequences of diffusion notation which has 1st and 2nd sequence offset of 1st and 2nd predetermined numbers of notations, respectively.

8. It is Approach of Determining Subscriber's Location in Communication System Which Has Two or More Base Stations Including Active Base Station and Non-Activity Base Station. : Phase of Starting at Least One of the Non-Activity Units as a Substation Station.

The phase which controls the group constituted from a subscriber by at least one of the active base stations which can receive a signal, and the started substation office so that each transmits a signal; it reaches. Phase of determining a subscriber's location based on each of said signal.

The approach characterized by constituting "Be alike."

9. Approach according to claim 8 further constituted by phase of determining the receipt time in subscriber about each of said signal.

10. It is Equipment Which Determines Subscriber's Location in Communication System Which Has Two or More Base Stations Including Active Base Station and Non-Activity Base Station. : A Means to Start at Least One of the Non-Activity Units as a Substation Station.

A means to control the group constituted from a subscriber by at least one of the active base stations which can receive a signal, and the started substation office so that each transmits a signal; it reaches. A means to determine a subscriber's location based on each of said signal. Equipment characterized by constituting "Be alike."

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

The location discovery approach and equipment in a CDMA system Technical field Generally this invention relates to the location specification approach and equipment of a subscriber unit in code-division-multiple-access (CDMA) wireless communication system in more detail about wireless communication system.

Background of invention In wireless communication system, it is desirable to pinpoint the location of the user who has started the call in many cases. There is 911 urgent service as an application of such a technique, and it enables it to dispatch the police / fire fighting / emergency service to the user under call origination.

There is unjust arrest and police criminal investigation etc. as other applications.

The cellular system already installed has almost no function about this point. For example, in an AMPS (Advanced Mobile Phone System) cellular walkie-talkie, a user's location can be pinpointed by judging whether it was used in order that which base station antenna might provide a user with service. However, since one cell has no less than 3-5 miles of radii, this information is not helpful in fact. Many of cell sites of the city section where a consistency is high are still smaller, and since many of cell sites of a city/suburbs use a sector-sized antenna and it is sector-sized in order to restrict the service area of one channel to one sector of a cell, the coverage area of a cell is still smaller. However, there are also still 1 square miles or more also of area in such a small cell. For this reason, when the most, it is not practical to pinpoint a user's location. The same approach as identifying a cell or a sector is used for the wireless system of others, such as US digital cellular (USDC) one and ** yaw ROPPA digitization mobile communication system (Group Speciale Mobile), therefore it cannot but be comparable as an AMPS system.

the case where these approaches and similar approaches are too expensive for many subscribers using, or it is triangulation although there is also the location specification approach of alternatives, such as triangulation to the subscriber unit under use of the global positioning system (GPS) unit in a subscriber unit or transmission, — in addition, the resource of the dedication which a price is high and requires time amount is needed.

Therefore, the approach of having been excellent in the improved opposite cost effectiveness which pinpoints a subscriber's location in wireless communication system is required.

Easy explanation of a drawing Fig. 1 is the simplified schematic showing the cellular system which can adopt this invention.

Fig. 2 is a block diagram of the CDMA receiver in the subscriber unit by the example of this invention.

Fig. 3 is drawing of location discovery of the CDMA subscriber unit by the example of this invention.

Fig. 4 is drawing showing the timing sequence used in case the propagation delay about the location of the CDMA subscriber unit by the example of this invention is determined.

Fig. 5 is a block diagram of the CDMA receiver in the base station by the example of this invention.

Fig. 6 is a time-line Fig. showing the propagation and time delay which are used in case a

subscriber is calculated according to the example of this invention.

Fig. 7 is a flow chart showing the process in which a subscriber measures a base station signal according to the example of this invention.

Fig. 8 is a flow chart showing the process in which a base station measures a subscriber signal according to the example of this invention.

Detailed explanation of a drawing The problem of these and others is solved by the approach and equipment by this invention which have been improved. The current suitable example of this invention is a system which determines a user's location in a code-division-multiple-access (CDMA/Code Division Multiple Access) cellular system. The estimate of a flight or the propagation time is created from the electric wave which reaches a subscriber unit first using CDMA modulation information, the — the electric wave received [1] can express the shortest path between a base and a subscriber, and can usually calculate the distance between a subscriber and a base station from time-of-flight estimate. A specific subscriber's location can be calculated by calculating the distance of plurality, for example, three steps, by the ability of the precision of the processing delay of measurement timing and others to restrict it. In a suitable example, the time of flight of the signal between each base and a subscriber is automatically calculated by the correlation receiving inside of a plane. In a processing phase, the transmission of a false noise (PN/Pseudo Noise) sequence coded signal by which time amount adjustment was carried out to below chip precision (for example, 1/16 of one chip), and correlation of this signal in the receiver using a correlation algorithm are included. A modulation sequence (for example, PN sequence) is a known thing, and since it is used for synchronization/diffusion discharge, the exact time of day of reception of a specific chip can be determined. By determining the receipt time about two or more related signals, time delay is calculated, and it can use in order to determine the estimate of a location.

In a certain example of activation, a subscriber determines related PN chip from a different base (the standard-basis ground and/or substation) transmitted to coincidence using known PN sequence and offset information, and determines the receipt time of these related chips further. From the difference between the receipt time, a part for time subtraction and range difference is determined. Location estimate is determined using the location which turns out to be a part for the range difference of a base. Other bases are considered as an active set (an auxiliary site is included if needed), and a subscriber enables it only for the case that the subscriber is communicating with one or two bases to perform timing measurement.

In other examples of activation, a receiving-side base site is controlled to perform timing measurement of the selected chip, and calculates a subscriber location similarly using the difference of the receipt time. An auxiliary site is controlled to receive the signal transmitted from the subscriber unit by interference etc. when an additional receiving site was required. In case of emergency, it acts as powering on of the subscriber unit to the maximum power level, at least three base stations receive, and it enables it to create the time amount estimate of a signal to it if needed. Furthermore, when more precise measurement is required, a special location message can be transmitted to a subscriber. If it receives, a subscriber will determine the chip/time offset about a reply signal, will encipher offset, and will transmit a reply signal. Offset is decoded, if the receipt time of the same chip (for example, the 1st chip of a frame), as having been used for offset decision is compared, a delay amendment time-of-day value will be determined about various propagation paths, and a location will be determined from there. Since it becomes difficult to obtain an input signal—ed finally on a still more distant base, urgent power average distribution can be performed on a neighboring base. This is because a compromise can be reached in capacity about the distance in a CDMA wireless system. A coverage is improved by this and more reliable location discovery can be performed.

With reference to Fig. 1, the cellular system which has the cell pattern of a hexagon with a base station 110, 120, 130 and a subscriber 140 is shown considering the whole as 100. The substation unit 121 is also located between bases 110, 120, 130.

The distance between a base 110, 121, 130 and the subscriber unit 140 is presumed by determining a flight or the propagation time of the 1st arrival electric wave, and this is measured from the conventional time as which it was beforehand determined until a receiver performed

correlation about a sending signal—ed. Since even the time base point of the arbitration of the receiving inside of a plane is measured, it is that which distance estimate may be evaluated excessively or may be evaluated too little (precise measured value is available only when more exact (it is moreover expensive) timing systems, such as a GPS signal or an atomic clock, are used in a subscriber 140), and this is still more difficult. Therefore, distance 150, 160, 170 is based on the correlation over a chip rate, respectively. A ***** is also sometimes shorter than an actual distance between each base 110, 121, 130 and a subscriber 140 (in about 814-nanosecond chip [ns] rate). (Namely, rate of ** diffusion signal determined with PN sequence rate by TTA (U.S. electronic communication link Semiconductor Equipment & Materials International) temporary standard IS-95A) Or it is desirable to perform timing measurement more quickly than about 250 meter per one chip (m), therefore a chip rate. In Fig. 1, distance 150 is overestimated and illustrated and the point 125 exceeding the actual location of a subscriber unit is shown. The point 115, 135 is overestimated similarly. These points are corrected by distance processing explained below, and the estimate far near a subscriber's true location is calculated.

Fig. 2 is a block diagram showing the CDMA subscriber unit 220 which has the CDMA receiver 201, the locator unit 202, and a transmitter 203. A receiver 201 has the common RF (radio frequency) front end 205 which supplies electric power to three independent lake inputs 210, 220, 230. These lake units 210, 220, 230 can be locked on three different received electric waves.

These electric waves are separated about 1 PN chip time amount or more than it, and this is a typical value about a direct sequence diffuse—spectrum (DSSS; direct sequence spread spectrum) receiver. The retrieval machine (searcher) 240 scans a new correlation peak at a rate quicker than a chip rate at the rate in which the resolution of 50ns clock—rate extent is possible in the suitable example, and reassigns a lake input based on the best estimate of current channel conditions. Usually, when the correlator of a lake 210, 220, 230 can be locked on three strongest available electric waves and the 2nd or 3rd base station can fully supply a strong signal, since it locks to other base station signals, these are secured. It is delayed beyond 1PN chip time amount, respectively so that these base station signals may also be set to an IS-95A standard. When there are only two base stations strong enough, the two electric waves are used for each base stations, respectively, and an electric wave strong against the 3rd turns into the remaining electric wave of one of base stations.

When a location discovery function is desired by the subscriber 200, in order to presume a location correctly, it is desirable that it is going to discover every one different base stations [three] about each electric wave so that sufficient information may be acquired. Therefore, in order to connect with three base sites, a lake 210, 220, 230 is adjusted so that at least three base unit signals may be decoded. When possible, answer a beacon demand, it is made to start the urgent pilot generators (substation unit 121 of Fig. 1 etc.) physically located between base sites, the area which has other reference signals is covered, and a subscriber may be able to be made to perform location presumption based on these pilot generators and a criteria base site. Such a helper unit has different PN offset from a surrounding base station, and is equipped with the GPS receiver for usually obtaining a synchronization/timing appropriately. These are combined with the base station or other controllers in an infrastructure by expedient means, such as wireless or a twisted pair cable. These startings are performed by the instruction to the local helper unit under the control from the demand to a controller by a subscriber directing preferably that only less than three bases can be used, or a service provision base station. Or a helper unit can also be equipped with the scan receiver which starts transmission during the period answered and restricted to the demand signal by the subscriber (for [in order / for example, / to minimize system interference] 5 seconds). By arranging appropriately, using these helper units, the indeterminacy in a specific location can be reduced or the location discovery precision in the strategic area of the business district of a main highway, a mall, or a core etc. can be raised generally. Since a subscriber's signal is receivable depending on the case, or there is only one base station with the interference restrictive property of a CDMA system also when [that] reverse, a helper unit is required to perform required multiplex reading.

The relative receipt time of each signal is determined by adjusting this using the information

about the tip (or peak) of the related correlation peak in a retrieval machine an offset part determined in a precision time amount matching circuit (for example, delay lock loop formations 215, 225 or 235 for each branching combined with filters 250-270 (DLL)). Preferably, a related correlation peak is a peak received within 1 mutual ***** in different branching. By this approach, the time of day (namely, chip location of PN sequence (for example, about 16,000 chip length)) to repeat (for example, number 245) when a tip is exact is determined with PN sequence number. Already determined PN sequence offset and system time-of-day +/with the base PN sequence same similarly about each base station – If the system design transmitted in original PN sequence offset is used, the difference of propagation path delay will be acquired from the difference of relative time of day. This is shown in Fig. 3. In time of day T0, although two bases B1 and B-2 have transmitted a base B1 transmits the PN chip 0, and since base B-2 has PN sequence offset of 256 chips, it transmits the PN chip 256. In the time of day T1 after location discovery was started, a subscriber judges that the tip of the PN chip 4 was received from B1. It is judged that the next tip of PN chip from base B-2 is the 280th of PN sequence, the difference of these receipt time and PN numbers to a propagation delay (PNB2- offset) (+ a receiving difference, T2-T1) — it asks with -(PNB1- offset) = (261-256) (+ (1/8))-(4-0) = 1 1/8 chip *814ns/chip =916ns. About a radio signal, in 3 meter [per// about] (m) every ns propagation velocity, this is made into propagation path distance and becomes about 300m difference. The precision of a location is restrained by only the system clock rate used and the degree of a synchronization. It is the transmission (namely, tip of a chip) which synchronized within 50 (or about 1 of chip rate/16)ns when all the base stations used GPS timing information.

The place of ***** is possible. In the local clock generated in the 20MHz clock rate same at least, location pinpointing in 100ns or 30m is possible.

It returns to Fig. 2, and it returns to each lake 210, 220, 230, respectively, and since a precise time amount adjustment signal is outputted, DLL215, 225, 235 adjusts a signal. As mentioned above, after a DLL output filters within a low pass filter (LPF) 250, 260, 270, respectively and equalizes the output of each DLL215, 225, 235 effectively by this about each channel preferably, it can function also as precision phase offset information that the receipt time of PN chip is adjusted. This equalized precision phase offset information is sent to the location retrieval machine 280 with the chip number / time of day / base identifier from the retrieval machine 240, or offset (namely, B1 – b3 information) (applied also to detection of PN chip / time of day). The location retrieval machine 280 gives the relative receipt time which acquires the phase offset information from each branching, and corrects the receipt time from the retrieval machine 240 about each chip and by which each branching was corrected. From the beginning (namely, time of day when the signal from a base 1 is received), B1 [i.e.,] the differences tB21 and tB31 of other signal B-2s and the receipt time about B3 are determined, and the correspondence distance dB21 and dB1 is determined. Thereby, they are bases 1 (110) and 2 (120).

3(130)

since — it turns out that distance is dB1, (dB1+dB21), and (dB1+dB31), respectively. Furthermore, PN offset can show the identifier of a base and the geographical location can be searched from memory 281. Judging [namely,] after this one which is illustrated in Fig. 4, it becomes an easy activity of activation of a retrieval routine to judge the terrestrial coordinates of a mobile station. The example of Fig. 4 defines three lines L12 (151), L23 (152), and L13 (153) using a known base location.

Distance dB21 and dB31 is subtracted from lines L12 (151), L23 (152), and L13 (153), respectively, and the remaining segments are perpendiculars N12 (154) and N23 (156). It is divided into two by N13 (155). The intersection of these lines N12 (154), N23 (156), and N13 (155) becomes a subscriber's 140 location. Next, it can also send so that this information may be sent to a service provision base station at the claimant of delivery and a service provision location register or a subscriber may use (for example, a map grid or other location specification equipments etc. which are not illustrated).

Or when positional information of a base site cannot obtain to a subscriber, phase offset, a chip, timing, and base offset information can be sent to a service provision base station within a location demand signal. Here, a location retrieval machine can access the database of itself and

can determine a subscriber's location. This positional information is returned to a subscriber or other demand equipments within a location response message next.

However, the suitable approach for the location specification using infrastructure equipment can be seen with reference to Fig. 5. Generally this drawing shows the block diagram of the CDMA infrastructure system 300 which has the 1st CDMA base station 301, a base 301 — 310, 320, and ... it has the common RF front end 305 which supplies electric power to four independent lake inputs indicated to be 330. These lakes can be locked on four different received electric waves from which it is separated of 1PN chip time amount at least. This value is a type value of a DSSS receiver. Two retrieval machines 340 can scan a new correlation peak, and can reassign a lake based on the best estimate of current channel conditions. Usually, four correlators of a lake 310,320,330 are locked on four strongest available electric waves.

When a location discovery function is desired, the two general technique, passive (that is, with no response of a subscriber unit) or an active target, is possible. In any case, in order to presume a location, it is desirable to discover at least three different base stations which can receive a subscriber signal so that sufficient information may be acquired. In the passive mode of the 1st example, an up link signal is detected using four lake branching 310,320...330 of a base 301. From each lake, the timing estimate (namely, adjustment value) of a correlated electric wave is generated using a delay lock loop formation (DLL-Delay Lock Loop).

This presumes more the same correlation time of day as the process which the above-mentioned subscriber unit used to accuracy. A retrieval machine, and the chip / time-of-day detector 340 are related with each branching, and is a signal.

The decision of the optimal branching for carrying out peak correlation and using is also made. (although based on the first peak preferably received about the same chip, in order to opt for the current best branching, other selection approaches may be used); in case this best branching signal determines PN chip and receipt time information like the subscriber retrieval machine 240, it is used.

In order to start a location specification process, in a suitable example, as for many, an instruction is exercised in a system 300 in local equipments, such as the migration exchange center (MSC:mobile switching center) 365 and a pin center/large of operation, in connection network, such as the public telephone switched network (PSTN:public switched telephone network) 375. A location specification demand is processed by the home location specification register (HLR:home location register) 366 next, and determines the base station which offers current service. If a location specification instruction is received, the processor 350 (and same processor of other service provision bases) of a base 301 will determine the chip receipt time using a detector 340. Preferably, this is performed by all the bases that determine the tip standup time of day of the group by whom PN chip was specified by judging the standup time of day of the chips (namely, PN sequence numbers 0 and 64,128 etc.) in the 64th [every] about a predetermined number of chips, for example, ten chips. Next, this information is sent to the location retrieval machine 361 of the appointed equipment (BSC:base site controller), for example, a base site controller, or the location retrieval machine 367 of HLR366 with that ID (identifier) by each base receiver. Thereby, each can determine a propagation delay difference using the difference of the receipt time of the same chip originating in one same chip transmission.

In other words, the difference of the receipt time in a different base serves as a propagation delay about each chip number, and a location can be determined by the approach same with Fig. 4 having been explained combining this information and the known location of a receiving-site base. The set (for example, continuing for about 500 microseconds*10 times per 64 chips) of two or more information can be taken in a comparatively short time frame, and the error of a location can be suppressed to the minimum by equalizing or best value adaptation calculating using the determined location (best-fit calculation), as for the ability of other approaches to be used for actual count, this contractor needs to recognize — it needs. For example, a propagation delay in the same system time of day with appointed time difference and an appointed chip number with system time of day. Also when an error with it happens, even if this has a clock cycle for

possible;50ns, it has an error more than what appears in transmission of the same (there is no timing error) chip. [new since the transmitting time of day of a different chip is restricted by the precision of a subscriber's clock rate] An important thing is Chip ID (for example, number of PN sequence).

It is using for the decision of a subscriber location the exact receipt time (for example, the tip or peak in the clock rate by which over sampling technique's was carried out) in a different base from a /location.

In the suitable example of active location specification, a bidirectional distance gaging system is realized using both the chip receipt time information from a subscriber, and a response indication of a certain kind.

Also in this example, a process starts in the location specification demand in the system infrastructure sent to the base 301 which is communicating with the subscriber. A processor 350 sends a location specification demand signal (LOC_S351), in order to encipher appropriately with an encoder 352 and the diffusion modulator 355. Using the system clock 353 (although it is the thing of the GPS origin preferably, the precision means of others, such as an atomic clock, may be used), the precision time-of-day regulator 354 (for example, strobe generator) controls a modulator 355, and outputs the tip of an output chip to a precision within 50ns precision preferably. A processor 350 also determines the precision system time of day (namely, chip 1024 of the sequence of 16384 chips in the system time of day TS (0)) of a criteria chip through a modulator 355 and a clock 353. From now on, other chip transmitting time of day can be determined later. After that, an output chip sequence is transmitted to a subscriber.

With reference to Fig. 2 once again, following a recovery and reception of the location specification demand signal 351, a processor 280 controls the retrieval machine 240 and determines following ID and the timing information of PN chip by the same approach as the above. The chip determined for explanation presupposes that it is 1088 (base PN sequence) of a subscriber's relative time of day TR (0). In order to offer the exact information about both-way time amount within a subscriber, a processor 280 determines the local time of day when the predetermined chip of a subscriber PN sequence is transmitted to a degree, with desirable (for example, chip 100) for convenience this predetermined chip being chosen as one of the repetitive trains transmitted from now on (for example, 50th chip of a subscriber's PN sequence) — although the chip of almost all others, for example, the 1st chip of the following 20ns frame, can also be chosen, it is desirable that it is made to carry out system location specification processing to a subscriber's precision timing appearance article affair at the minimum. Anyway, the local time of day of the chip chosen about the output from the modulator 291 of a transmitter circuit 203 is determined by calculating to the forward direction, in order to determine output time of day of a current chip (minding PN / time-of-day detector 292) and to determine predetermined chip output time of day (for example, the chip 100 of TR (241/16)), relative time amount measured at intervals of a chip rate here). Of course, when there is no transmission in a present progressive, sufficient time delay (for example, about 2 seconds) to which a base can pursue a subscriber's PN sequence is given before transmission of a predetermined chip. Next, a processor controls a modulator 282 to output correctly a periodic group's consecutiveness chips (for example, chip 150,200 etc.) to a predetermined period to output a predetermined chip for the location specification reply signal RESP282 for enciphering with an encoder 290 to delivery and predetermined time of day (namely, TR (24 1/16)) correctly, and supervise the periodic group of a chip. In RESP282, they are base chip information (1088 TR (0)) and predetermined chip information (when already not being known by the infrastructure as a profile of 100, TR (24 1/16)) and a subscriber unit). The predetermined subscriber delay factor (that is, finishing [proofreading/count]) (namely, time amount to which the signal of an antenna reaches the retrieval machine 240 and time amount concerning an output signal being picked out with an antenna, after time amount precision outputting from a modulator 291) about the delay after prior acquisition and an output is contained.

It returns to Fig. 5, and other communication link bases are told about a system so that storing of location specific information may be begun, at the same time it controls a base 301 so that a system sends the location specification demand signal 351. When the base under communication

link (namely, inside of a software hand off) or the base which can receive a subscriber signal is less than three, origin equipment (for example, a location retrieval machine / processors 361 or 367) is ordered starting reception in the frequency as which the subscriber was specified to one or more substation offices, such as the base 356 in the perimeter of a service provision base. In the thereby easiest example of activation, when, substation used as the receiver which has a precision system clock (for example, clock amended by GPS) and which can be aligned is not connected to BSC through wiring, a substation A substation is realizable as a fixed subscriber unit (wireless access fixed unit (WAFU, wireless access fixed unit)). It only differs from a subscriber that WAFU operates by the system time (minding for example, a GPS clock). In the case of the latter example, WAFU communicates location specification demand information through the service provision base station 301 of itself, for example, a base.

All the receiving bases 301, for example, a base, and a substation 356 will start storage of a subscriber chip / time information, if a location specification demand is started. The information memorized is time of day (for example, tip receipt time), a chip number, etc. of each chip which are received at a predetermined period; with desirable although it becomes about 25,000 entry with one 20ms frame in this case rather than it saves each chip using a periodic number of chips (for example, chip in the 50th [every] within a sequence) on all receiving bases — when it is this latter, a subscriber is set up as mentioned above and chooses the predetermined chip which is one of the periodic chips of these (chip 100 etc.), in order to make an error into the minimum, as long as information is collected about the same chip (group) on all bases, it should understand to this contractor that the period or the specific chip (for example, the 1st chip of a frame) of a number of arbitration can be used — it needs. The subscriber set up appropriately desirable for convenience; which chooses a predetermined chip so that it may be in agreement with the chip (group) currently supervised by the base, and simplifies next count by that cause — this selection. Even if it carries out based on preliminary programming, you may carry out based on the data within the location specification demand signal 351 which shows the chip (group)/period supervised (in this case, what is necessary is to output only a predetermined chip (group) to a precision).

If a diffusion RESP signal (preferably sent through the formation of an in band signal by on-going voice/data communication of arbitration) is received from a subscriber, the processor 350,358 of a base 301,356 will detect a signal and predetermined chip information, and will send the chip / time-of-day pair of a predetermined number to the location retrieval machines 361 or 367. For example, in order to raise precision and to equalize from (it begins from [450, TS (3/8 8/16)] for example, pair (100, TS(28 7/16)), (150, TS (78 7/16)), and ...) a predetermined chip and its receipt time RESP signaling information (for example, a base chip / time-of-day pair — eight a chip / time-of-day pairs are sent with (base) 1088, TR(0)), predetermined chip / time-of-day pair ((subscriber) 100 predetermined, TR (24 1/16)) and a known delay factor (4/32). The time line which shows this sequence is shown in Fig. 6. TS (0) expresses initiation system time of day, it is shown as 0th bit of a system clock for convenience here, and TR (0) expresses a subscriber's relative clock time of day. PNB1 (1088) expresses the 1088th chip within a subscriber's PN sequence. Thereby, the base chip 1088 is outputted in the system time of day 0, and only the transmitting time delay delta tB1 is emitted from a base antenna later. after a propagation delay deltaP1 and subscriber receiving time delay deltaS, a detector 240 determines the chip 1088 received by TR (0) from a subscriber antenna to a detector 240 namely. Next, a processor 280 determines the 50th chip next to a subscriber sequence as a chip 100, and it calculates that the output time of day of a chip 100 is set to TR (24 1/16) from current subscriber chip / time of day. The proofread delay delta rS (delay from an output to antenna emission) and delta tS is known, namely, since each is 2/32 chip, a subscriber sends information, for example, [(1088, TR (0)) (100, TR (24 1/16)), and the RESP signal 282 containing [4/32]].

the detector 240 of a base 301 receives the subscriber chip 100 in the system time of day TS (28 7/16), a base 357 receives it in time of day TS (29 7/16), and propagation and the reception delay from an antenna to a detector namely, — are delta p2, delta rB1, and delta P3 and delta rB2, respectively at this time. Same repetitive measurement can also be performed, for example,

the base 301 — time of day TS (78 7/16) — a chip 150 — receiving — a subscriber — the output time of day of a chip 150 — TR (74 1/16) — that is, it is controlled to become after 50 chips (40,700ns) correctly.

After the pair of a predetermined number is determined, a chip / time information, and reply signal information are sent to the location retrieval machines 361 or 367. The retrieval machines 361 or 367 calculate a propagation delay, deltaP1-deltaP3 [for example,], by other known information being used for them next. In this case, proofread base delay delta tB1, delta rB1, and delta V/B2 is considered as 5/32, 3/32, and 3/32 chip. Since deltaP1 is fundamentally the same as deltaP2, $2\text{deltaP1} = (\text{TS}(28\ 7/16) - \text{TS}(0)) - (\text{deltaTB1} + \text{deltaRB1}) - (\text{TR}(24\ 1/16) - \text{TR}(0)) - (\text{delta rS} + \text{delta tS}) = (28\ 7/16) - (8/32) - (24\ 1/16) - (4/32)$ it becomes ≈ 4 chip.

Thereby, deltaP1 is two chips, i.e., 1628ns, and propagation path length is set to about 488m (they are + / the total ≈ 30 m indeterminacy in 100ns). If deltaP1 is known, in the case where deltaP3 is calculated similarly and illustrated, the time amount of three chips and the distance of 733m will be acquired. Propagation path length can be calculated about at least three receivers, and what the positional information about a receiving base is searched for can determine by calculating one point (or highest small field of a probability) that the whole of each propagation path crosses a subscriber's location (from databases 362 or 368). This process is repeated about each set of time of day/chip. Calculated each point (or center of gravity of a possible field) is used for a subscriber's spotting. Although equalization can perform this for example most easily, the suitable process of the arbitration which makes an adaptation decision of the point/the field where a probability is the highest from two or more point/fields can also be used. The location of the point/field where a probability is the highest is preferably memorized by the user profile database 369 of HLR366. The whole process is repeatable after 1 times or more of the time interval for several seconds or about several minutes. At furthermore, this time The subscriber clock exact enough is used, which determines the rate and direction of migration of a subscriber, using the field where a probability is the highest two or more — if fluctuation is smaller than 50ns between the extended periods of several minutes, and offset of the subscriber clock from system time of day is known during the period namely, repetitive detection can be performed on a base, without repeating a demand signal. At the end, the rate/the direction of the determined location and migration are sent through the demand equipment 370 of an origin, for example, an operator, and PSTN375.

If a specific advantage over the un-active process in the case of using an active location specification process is desired, I hear that it can judge three-dimensions information more correctly, and there is. This is useful especially in the city section or the hill section to which the inclination of a propagation path may become large especially 0 times or more from a horizontal, although the precision of a passive process can be raised using three-dimensions **** of a base, and the known geographical feature of the 1st rough subscriber location, as for the ability of a better rough value to be drawn, in contrast with the case of only the difference of the propagation time, this contractor needs to understand from the measured propagation time — it needs. Determining the three-dimensions field of a possible location, since the determined propagation path is exact at three dimensions is only a problem which carries out additional processing of a z-axis (namely, three dimensions) coordinate, and those x-axis coordinates and y-axis coordinate of a base site location, if this is compared with a known building and a terrain intelligence — the inside of an independent building — +/— the location specification beyond less than or it is attained by the eighth [—] floor (by indeterminacy for 100ns). The field of the location where a probability is still higher can also be narrowed using additional information, such as a path loss property with the certainty into the signal strength received [relative] and a building.

Fig. 7 shown by 400 in the whole is a flow chart explaining the system process of the subscriber who measures a base station signal, in order to obtain location estimate. A process starts with block 405. This block expresses generating of the location specification instruction which should be executed by the subscriber (automatically based on the index of others, such as a movement sensor in which starting of a subscriber or an automobile accident is shown), 415 by which a subscriber's situation is checked and decision making of whether a subscriber is among the

software hand off of three directions is made in block 410. In the case of a no, it is judged whether block 420 is performed and there are three bases in a candidate set. When there is nothing, it is the decision-making block 425 and the threshold of the additional base to a candidate set is checked. When this is not the minimum value, a threshold is lowered with block 430 and it returns to the process step 420. It is block 425 and block 430 is performed when it is already in the minimum level. This block distinguishes the location specification function of an urgent function and an un-urgent function. Only when the function which is not urgent is processed by this, and operating level is not high, modification of system level is allowed. This is because it may become impossible for a user to receive service, when interference level is raised. Block 460 is performed in non-emergency when a system load is expensive. When emergency is directed, block 455 is performed before block 460. Preferably, an auxiliary pilot generator can be aligned, and this can send, which answers the urgent beacon signal which answers automatically and happens, or an emergency signal to a service provision base, and can perform processing for controlling to start a substation. In the case of the latter, the 2nd un-urgent demand signal is used similarly, but a starting instruction is generated when telling that the system load of a control processor (for example, the processor / retrieval machine 361 of BSC360 of Fig. 5) is lower than a load threshold at this time. The pilot generator of the neighborhood which includes more the service area by two or more sites in perfection is started, and a subscriber enables it to receive a signal from two or more bases with block 455 by this. In block 460, it is judged whether a subscriber is in the software hand off of three directions. In the case of a no, a subscriber is ordered forming the 3 direction software hand off conditions using the maximum electric wave from at least three base stations (465). After block 465 is completed when the result of 460 is yes or, block 440 is performed, and collection of data is performed as explained in Fig. 2. Processing of location estimate is performed using this data (for example, within the retrieval machine 280 using the additional data from the memory 281 of Fig. 2).

A system returns to nominal conditions (445).

Block 440 is performed, when it returns to block 415 and a subscriber is in the 3 direction hand off. When it returns to block 420 and there are three bases in a candidate set, block 435 is performed and three different bases are put into an active set.

Next, as mentioned above, block 440 is performed and then block 445 is performed.

Fig. 8 shown by 500 in the whole is a flow chart explaining the process of the base station which measures a subscriber unit, in order to obtain location estimate. A process starts with block 505 and a location specification function is started here. In block 510, a subscriber's situation is checked and decision making of whether a subscriber is among the software hand off of three directions is made (515). It is judged whether it performs by block 520 being arbitrary in the case of a no, and there are three bases in a candidate set. When there is nothing, it is the decision-making block 525 and the threshold of the additional base to a candidate set is checked. When there is this [no] in the minimum value, a threshold is lowered with block 530 and it returns to the process step 520. It is block 525 and becomes less more exact than the case of the request which has three bases in measurement since there are only two bases at this time, although block 535 is performed and processing of location presumption is continued when it is already in the minimum level. Block 540 is performed, when it returns to block 515 and a subscriber is in the 3 direction hand off, or when there are three bases in a candidate set with block 520. In block 540, it is checked that three base stations are the active states which receive a subscriber's signal. Next, block 545 is arbitrary and is performed. This block judges whether each base can receive a subscriber. When each base can be received, block 550 is performed, in the case of active mode, in the case of delivery and both the modes, available data are collected for a location specification demand signal, and location estimate is processed by the above-mentioned approach. Block 555 is performed, all parameters are returned to a normal state, and measurement is ended. It returns to block 545, and when the base which can receive a subscriber is less than three, it is judged with block 546 whether a substation unit is usable. When usable, block 547 is started for the auxiliary site of a part, and it is judged whether emergency is directed with block 560. In the case of a no, only the base received can be used for measurement, for this reason the quality of estimate may deteriorate. When emergency is

directed (for example, urgent demand from the license equipment connected to the subscriber signal of No. 911 being dialled, or the infrastructure etc.), it is judged whether block 565 is performed and a subscriber unit is in maximum electric power. In the case of a no, block 570 is performed, power is increased, and a process returns to block 540. When it is in maximum electric power with block 565, it is block 575 and it is judged whether each base can receive a subscriber. In the case of yes, block 550 is performed, when that is not right, the loads of a cell are reduced with block 580, and reception of a subscriber unit increases the scope of the cell in a difficult active set. Next, it is judged whether the power average distribution limit was reached, it is yes not come out.] it is judged whether the power average distribution limit was reached, it is yes and block 550 is performed, the decision-making block 575 is performed once again, and each base can receive a subscriber.

As mentioned above, probably, it will be clear to this contractor that the approach and equipment which presume the location of the subscriber unit of the wireless communication system to which the purpose, an above-mentioned target, and an above-mentioned advantage are satisfied completely by this invention were offered.

Although this invention was explained about the specific example, a possible thing's many alteration, correction, and deformation are clear to this contractor from the above-mentioned explanation, for example, although the circuit of the retrieval machine 240/280 of the subscriber unit 200, the retrieval machine 340 of a base station 301, a processor 350, and others is explained about the relation between specific logic / functional circuitry, this contractor needs to understand that these can be embodied in various approaches, such as a processor set up and programmed appropriately, and ASIC (application-specific integrated circuit), DSP (digital signal processor), — it needs, it not only determines a location, but furthermore, this invention is applicable to the CDMA system of arbitration using a diffusion notation sequence through chip information within an IS-95CDMA system. For this reason, this invention is equipped with the approach and equipment which can determine the location of the subscriber unit in the CDMA wireless communication system which has two or more base stations in the 1st example of active retrieval. This approach and equipment are (a) diffusion notation.

The 2nd diffuse-spectrum signal including the response message from the phase (means)(b) subscriber unit which sends the 1st diffuse-spectrum signal which includes the location specification demand to a subscriber unit from the 1st base station among two or more base stations diffused by the 1st sequence of ***** Are the phase (means) received in the 1st base station, and this 2nd diffuse-spectrum signal is diffused by the 2nd known sequence of a diffusion notation. A response message receives the predetermined notation of the 2nd sequence in the 2nd base station at least with the phase (means). (c) 1st base station constituted by the receipt time of the 1st notation of the 1st sequence, and the transmitting time of day of the 1st notation of the 2nd sequence, and sets it to the 1st and 2nd base stations. The receipt time of the 1st notation of the 1st sequence by phase (means), and (d) subscriber unit which determine the 1st and 2nd receipt time of a predetermined notation, respectively. It is characterized by being constituted according to the transmitting time of day of the 1st notation of the 2nd sequence by the subscriber unit, the 1st and 2nd receipt time of a predetermined notation, and the phase (means) of determining the 1st and the location of the known information concerning the 2nd base station at least to a subscriber unit. The further example is equipped with the approach and equipment which can determine the subscriber location in the CDMA wireless communication system which has two or more base stations. This approach and equipment are set to each of the (a) 1st base station, the 2nd base station, and the 3rd base station. From a subscriber Among the known sequences of the diffusion notation in the phase (means): (b) 1st base station which receives the signal formed through the modulation of the known sequence of a diffusion notation, the 1st receipt time of one notation, Phase (means), and the (c) 1st, 2nd, and 3rd receipt time which determine the 2nd receipt time of the notation in the 2nd base station, and the 3rd receipt time of the notation in the 3rd base station, it is characterized by further known information about the 1st, 2nd, and 3rd base stations being consisted of by phase (means), which determines the location of a subscriber unit in a location specification processor. It is the subscriber unit which can determine an own location while

communicating in still more nearly another example within the CDMA wireless communication system which has two or more base stations. The 1st signal from the 1st base station of the base stations of (a) plurality It is a receiver means to receive the 2nd signal from the 2nd base station of two or more base stations. The 1st and 2nd signals By the 1st known sequence of a diffusion notation, and the 2nd known sequence of a diffusion notation, respectively Detector means, and the (c) 1st and 2nd receipt time which determine the 1st receipt time of the 1st notation of the receiver means; (b) 1st sequence which receives the signal formed through the modulation, and the 2nd receipt time of another notation of the 2nd sequence, It is characterized by further known information about the 1st and 2nd base stations being consisted of by location specification processor, which determines the location of a subscriber unit. Still more nearly another example An active base station and a non-activity unit It judges whether at least three active base stations can receive a signal from a subscriber, phase; (b) which receives the signal which is the approach of determining a subscriber's location within the CDMA communication system which has two or more included base units, and tells (a) emergency — Among the active base stations which can receive a signal from the phase; (c) subscriber who starts at least one of the non-activity units as a substation office when unreceivable, at least three About each diffuse-spectrum signal transmitted at the phase; (d) step (c) controlled to transmit the diffuse-spectrum signal with which each has the same notation sequence for the group who consists of a substation station started at the step (b) respectively — a notation — a sequence — the same — a notation — a subscriber — it can set — each — the receipt time — determining — the above — each — the receipt time — containing — a response — a subscriber — from — sending — a phase —; — and — (— d —) — the above — each — the receipt time — It is characterized by further known information about a group being consisted of by phase; which determines a subscriber's location.

Therefore, this invention is not restrained by explanation of the aforementioned example, but includes these [by the pneuma and the range of a claim of attached] all alterations, corrections, and deformation.

[Translation done.]

* NOTICES *

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1. This document has been translated by computer. So the translation may not reflect the original precisely.

2.*** shows the word which can not be translated.

3.In the drawings, any words are not translated.

MEANS

It is the phase where are a (means), diffuse this 2nd diffuse-spectrum signal by the 2nd known sequence of a diffusion notation, and a response message is constituted by the receipt time of the 1st notation of the 1st sequence, and the transmitting time of day of the 1st notation of the 2nd sequence.

[Translation done.]

* NOTICES *

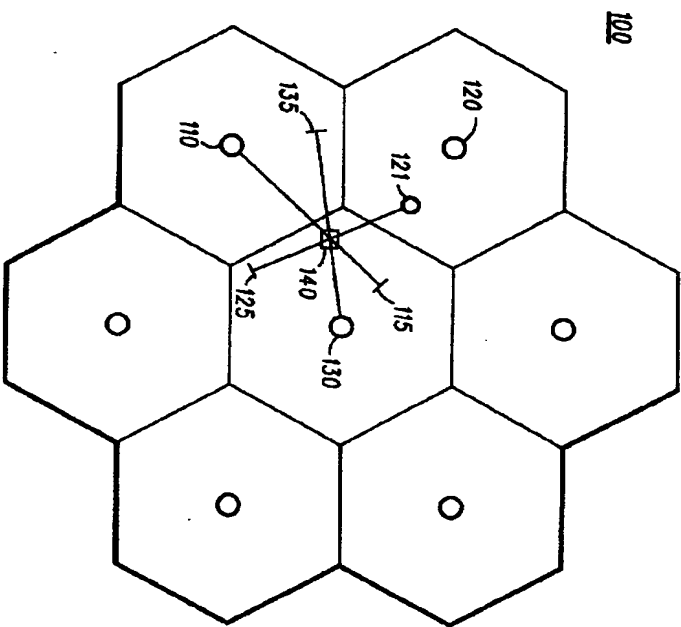
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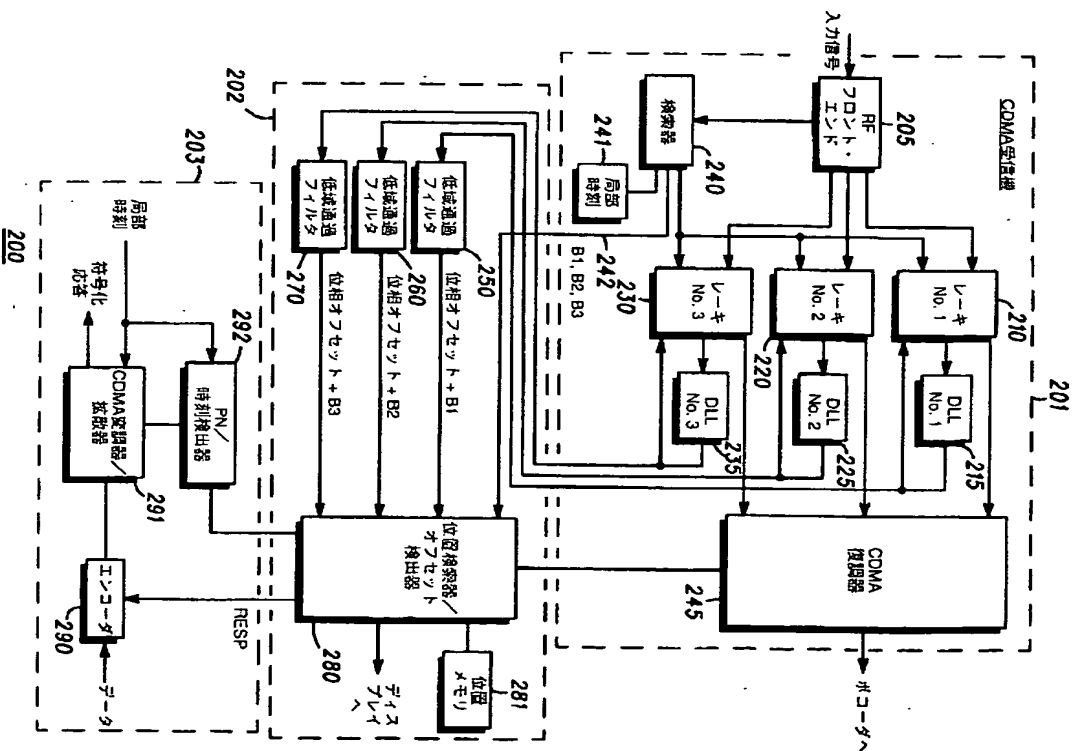
2.*** shows the word which can not be translated.

DRAWINGS

[Drawing.1]
第1図

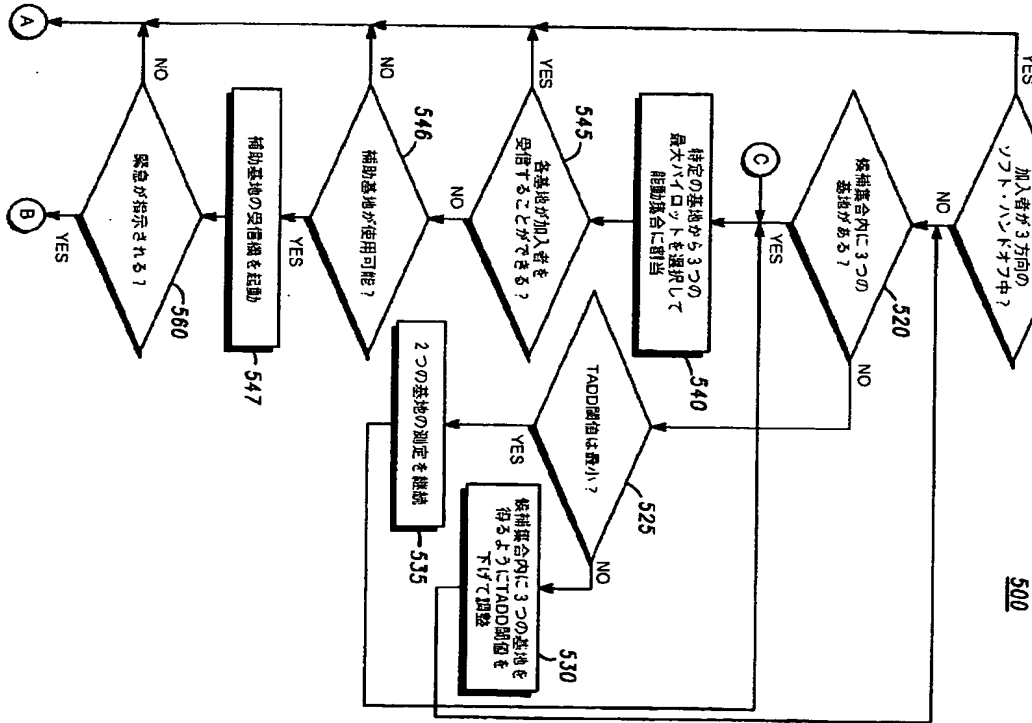
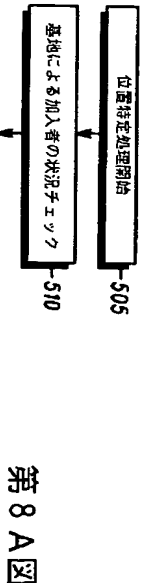
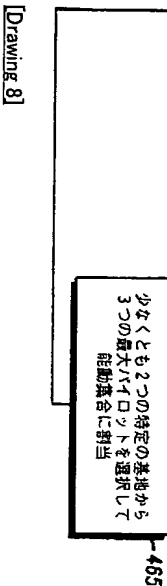
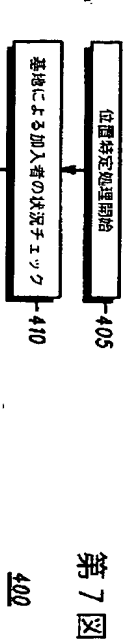


[Drawing.2]



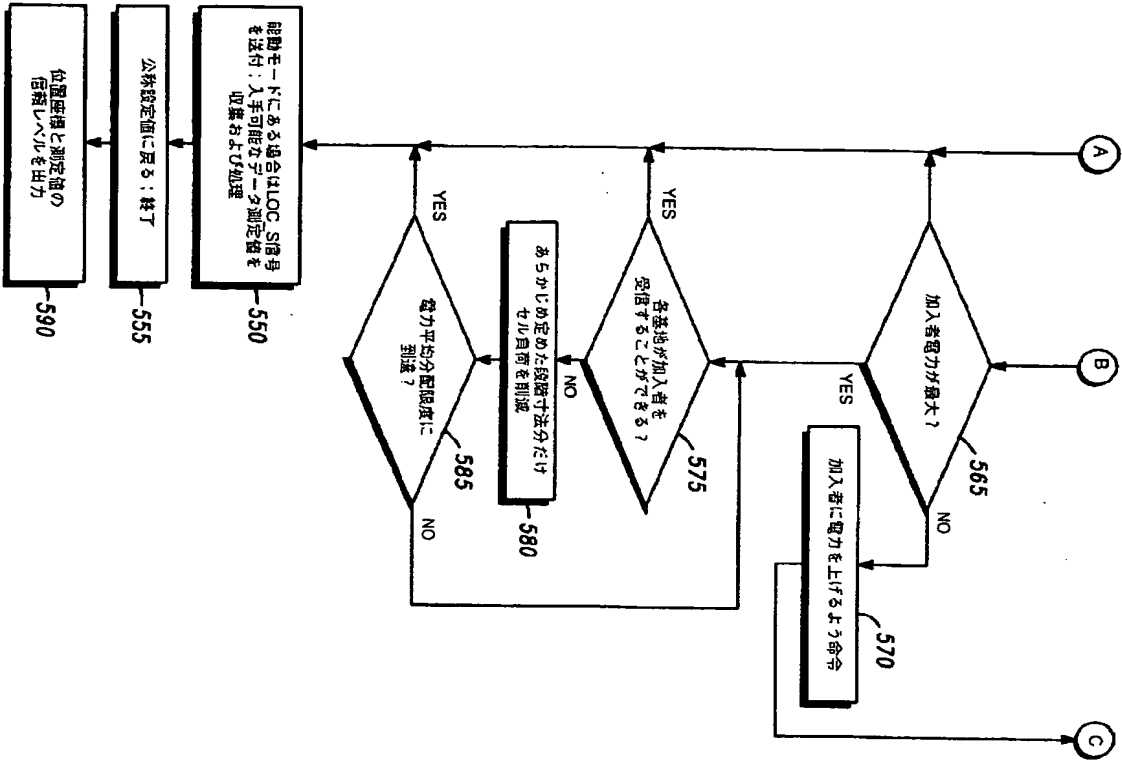
[Drawing.3]

第2図



第 8 図

500



[Translation done.]